MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Permitting and Compliance Division
Water Protection Bureau
P.O. Box 200901
Helena, MT 59620-0901

Permit Fact Sheet
Montana Ground Water Pollution Control System (MGWPCS)

Permittee:	Sussex Development Inc.
Permit No.:	MTX000210
Receiving Water:	Class I Ground Water
Facility Information	
Name:	Heron Creek Subdivision
Mailing Address:	Sussex Development Inc. 184 Saddle Mountain Road Clancy, MT 59634
Contact:	Ron Bartsch
Phone:	406-431-9663
Fee Information	
Number of Outfalls:	1
Outfall - Type:	001a Zone 1 Drainfield 001b Zone 2 Drainfield

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I. Permit Status

This is a new permit for a proposed wastewater treatment and disposal system that is part of a subdivision located south of Helena, MT. The Department received the initial permit application and supporting documents on February 26, 2008. The application was determined to be deficient on March 6, 2008. The Department received a response to the deficiency letter on March 25, 2008. Additional permit application materials were received April 17, 2008. The permit application was deemed complete on June 17, 2008.

II. Facility Information

A. Facility Description

Permit application materials were submitted by Great West Engineering (GW), Inc on behalf of Sussex Development Inc. The permit application is for the Heron Creek Subdivision (HCS). The permit application reported a maximum daily design flow of 27,250 gallons per day from a 109 dwelling unit subdivision (44 condo units and 65 single family units). The wastewater treatment system includes a centralized Advantex recirculation trickling filter (RTF). Residential wastewater will receive primary treatment in individual septic tanks prior to being sent to the recirculation tanks. Secondary treatment will occur in two recirculation tanks, (30,000 and 25,000 gallon capacity) and a RTF. Treated effluent will then be conveyed to a 4,000 gallon dose tank. From this point treated effluent will be sent to one of two 3,400 gallon dose tanks and then pressure dosed to one of two drainfields.

The proposed wastewater treatment facility will discharge via two drainfields. The western most drainfield and the southern drainfield will be deemed outfalls 001a and 001b respectively. The drainfields are located on the hydraulically up gradient side of the HCS. Outfalls 001a and 001b are situated in T10N, R2W, in the northwest ¼ of Section 12, or N 46º38' 35" latitude and W 111º 48' 14" longitude.

B. Effluent Characteristics

The wastewater treatment system is a new system therefore no effluent samples have been collected or analyzed. However, the applicant has submitted effluent data from a similar RTF system provided by Advvantex, of the wastewater treatment system. Effluent characteristics of similar RTF systems are listed in Table 1.

Table 1 Effluent Characteristics

Parameter	Units	Maximum	Minimum
Total Suspended Solids (TSS)	mg/L	25	10
Total Dissolved Solids	mg/L	770	630
Biological Oxygen Demand (BOD)	mg/L	25	10
Escherichia Coli	mpn/100 ml	200,000	40,000
Total Ammonia, as N	mg/l	8	5
Total Kjeldahl Nitrogen, as N	mg/L	12	8
Nitrate + Nitrite, as N	mg/L	20	16
Total Phosphorous, as P	mg/L	10	7

III. Proposed Technology Based Effluent Limits

A level II system must provide at least a 60 % removal of total nitrogen in raw wastewater or produce effluent with a total nitrogen concentration of 24 mg/L or less [ARM 17.30.702 (11)]. The proposed system meets the definition of level II treatment (Regensburger 2004). The Department will use 24 mg/l as an effluent limit because of the inability to calculate a reliable value of 60 percent removal of total nitrogen from a wastewater treatment system incorporating

individual septic tanks at each residence. A 60 percent removal rate would have to be calculated for the entire treatment system. A sampling and analysis plan for determining a 60 percent removal rate was not outlined in the permit application. Therefore a value of 24 mg/L will be used as a permit effluent limit. Because an additional 7% of nitrogen removal is assumed to occur within the drainfield a proposed limit of 26 mg/L will be used. The technology-based permit limit for total nitrogen will be set at 26 mg/L (see Table 1).

The proposed technology based effluent limits for outfall 001a and 001b are presented in Table 1.

Table 1. Technology Based Effluent Limit for Outfall 001a and 001b

Parameter	Concentration (mg/L) Daily Maximum (1)
Total Nitrogen as N	26.0

(1) See definitions, Part I.A of the permit

IV. Water Quality Based Effluent Limits

A. Receiving Water

The applicant submitted ground water quality data from an up gradient onsite monitoring well (Department of Natural Resources and Conservation Well ID # : Heron CR #3). Ground Water quality sampling that occurred on December 18, 2007 reported nitrate plus nitrite (as N) concentration of 4.89 mg/L, total nitrogen 5.4 mg/L, conductivity 637 µmhos/cm, total dissolved solids 389 mg/L and chloride 16 mg/L. The static water level in this well was reported as approximately 58 feet below ground surface. This well is finished at approximately 75 feet.

Additional groundwater quality sampling event took place from the same well on January 29 and April 2, of 2008. Conductivity values reported from these sampling events were 644 and 649 µmhos/cm respectively. The applicant submitted ground water analytical data from one well. The results from the up gradient well (eastern most well, DNRC well ID #: Heron Cr #3) are listed in table 2. Therefore, the receiving water for Outfall 001 is class I ground water as defined by the Administrative Rules of Montana [ARM 17.30.1006 (1)(a)] (ground water with specific conductance equal to or less than 1,000 microSiemens/cm). Class I ground water is to be maintained for the following beneficial uses with little or no treatment: public and private water supplies, culinary and food processing purposes, irrigation, drinking water for livestock and wildlife and for industrial and commercial uses. Class I ground waters are considered high quality waters and are subject to Montana's Nondegradation Policy [75-5-303, Montana Code Annotated (MCA)]. Water quality human health standards (DEQ-7, February 2006) apply to concentrations of substances in Class I ground waters. Pursuant to ARM 17.30.1006(1)(b)(ii) for parameters that are not listed in DEQ-7, there shall be no increase in Class I receiving water concentrations to levels that render the water harmful, detrimental or injurious to the beneficial uses listed for Class I waters.

The average hydraulic conductivity of the aquifer is 140 ft/day. This estimate is derived from well tests conducted on onsite wells. An aquifer test (24 hour pump test) was conducted in well #3, wells 2 and 5 were utilized as observation wells. The hydraulic gradient in the shallow ground water was reported as 0.023 ft/ft, estimated from onsite monitoring wells.

Table 2. Receiving Water Ground Water Monitoring Results

Date Samples	pH	Total Dissolved Solids (mg/L)	Total Nitrogen (mg/L)	Nitrate + Nitrite (mg/L)	Chloride (mg/L)	Conductivity (umhos/cm)
December 18, 2007	7.6	389	5.4	4.89	16	637
February 29, 2008	7.8	373	3.9	3.87	17	644
April 2, 2008	7.8	373	3.6	3.65	17	649

Well logs drilled onsite indicated sandy silt occurring from 0- 8 feet and fine to medium grained sand with medium to course gravel occurring from 8-17 feet. The National Resources Conservation Service (NRCS) indicates that soils in the vicinity of the wastewater treatment system are approximately %12 Aridic ustifluvents Loam (0-5 inches loam, 5-25 inches stratified gravelly sandy loam to loam, 25-60 inches extremely gravelly loamy sand), %77 Sappington-Amesha Loam (0-4 inches loam, 4-6 inches clay loam, 6-9 inches loam, 9-20 loam) and 8% Crago-Musselshell Loam (0-4 inches gravelly loam, 4-32 inches very gravelly clay loam, 32-60 extremely gravelly loam).

The ground water flow direction in the vicinity of the drainfield is approximately N41°E based on groundwater table elevations measured in onsite wells. Based on proximity, the nearest surface water is Spokane Creek approximately 2,250 ft east of the proposed discharge location and across gradient. Spokane Creek is a tributary to Hauser Lake and flows down gradient of the wastewater treatment system. Based on the direction of ground water flow, the nearest surface water to Outfalls 001 is also Spokane Creek approximately 3,000 feet down gradient.

B. Basis for Water Quality Based Effluent Limits

ARM 17.30.506 (1) states that a discharge to state waters shall not cause a violation of a water quality standard outside a Department authorized mixing zone.

Water quality limitations must be established in permits to control all pollutant or pollutant parameters that are or may be discharged at a level which will cause, have reasonable potential to cause or contribute to an excursion above any state water quality standard. The permittee must comply with the permit limits developed by the Department in accordance with the Montana Numeric Water Quality Standards included in Circular DEQ-7 (February 2006) and protection of beneficial uses (ARM 17.30.1006). Ground water quality standards may be exceeded within a Department authorized mixing zone (ARM 17.30.1005), provided that all existing and future beneficial uses of state waters are protected [ARM 17.30.506 (1)].

C. Nitrate

Class I ground water is considered high quality water and is subject to Montana's Nondegradation Policy 17.30 subchapter 7. The wastewater system is considered a new source as pursuant to ARM 17.30.702 (18) (a). Total nitrogen is the sum of inorganic nitrogen and organic nitrogen concentration (nitrate + nitrite as N (NO_3+NO_2-N) plus ammonia and organic

nitrogen as N). The Department assumes all the nitrogen discharged to the drainfield in the effluent is converted to nitrate as nitrogen. The allowable discharge concentration is derived from the mass balance water quality equation, which considers dilution and background concentration of the receiving water (EPA, 2000).

$$C_2 = \frac{C_3(Q_1 + Q_2) - C_1 Q_1}{Q_2}$$

C_1= ambient ground water (background) concentration, mg/L
C_2 = allowable discharge concentration, mg/*L*
C_3 = ground water concentration limit for pollutant (from Circular DEQ-7 February 2006 or other appropriate water quality standard) at the end of the mixing zone.
Q_1 = ground water volume (ft^3 / day)
Q_2 = maximum flow of discharge (design capacity of system in ft^3 / day)

The volume of ground water that will mix with the discharge (Q_s) is estimated using Darcy's equation: $Q_1 = K\ I\ A$.

Where: Q_1 = ground water flow volume (ft^3/day)
K = hydraulic conductivity (ft/day)
I = hydraulic gradient (ft/ft)
A = cross-sectional area (ft^2) of flow at the down-gradient boundary of the 500-foot mixing zone.

$$(Q_1) = (140\ ft/day)(0.023\ ft/ft)(8{,}160\ ft^2)$$
$$Q_{1\text{-}001} = 45{,}885\ ft^3/day$$

The design capacity of the entire wastewater disposal system is 27,250 gpd, or 3,643 ft^3/day. Hydraulic conductivity (K) was estimated at 140 feet per day (ft/d). The gradient was calculated based on well data from wells surrounding the site, at 0.023 ft/ft. The area (A) is calculated by the width of the source perpendicular to the ground water flow direction, times a standard mixing zone depth in the groundwater of 15 feet. The applicable water quality standard for nitrogen of 7.5 mg/L must not be exceeded at the end of the mixing zone. The permit application materials indicated a Nitrate plus Nitrite concentration of 4.89 mg/L for ambient ground water quality. Therefore a concentration of nitrate (as N) of 4.89 mg/L was used in calculating the allowable nitrogen concentration at the end of the mixing zone. It is assumed that the entire total nitrogen load in the seepage effluent converts to nitrate and enters the ground water.

$$C_2 = \frac{7.5\ mg/L\ (45{,}885\ ft^3/day + 3{,}643\ ft^3/day) - (4.89\ mg/L)\ (45{,}885\ ft^3/day)}{(3{,}643\ ft^3/day)}$$

$$= 40.2\ mg/L$$

The projected daily maximum concentration of the total nitrogen in the effluent discharged to groundwater must not exceed 40.2 mg/L at Outfall 001a and 001b. The Department assumes an additional 7% nitrogen removal occurs within the drainfield providing a final total nitrogen

concentration discharged to ground water of 43.0 mg/L. This effluent limit ensures the nitrate concentration at the end of the ground water mixing zones is at or below the nondegradation significance criterion of 7.5 mg/L.

D. Phosphorus

Phosphorus is removed mainly through soil sorption processes, which vary based on soil composition. The 50-year breakthrough nondegradation criterion is based on the amount of soil available to adsorb the average load of phosphorus from the wastewater source, between the discharge point and the closest downgradient surface water. The total phosphorus limitations are imposed to ensure that the quality of the effluent meets the nondegradation limit prior to discharge into any surface water [ARM 17.30.715(1)(e)]. The effluent limits do not include a concentration limit for phosphorus because of the method used to determine compliance with the 50-year breakthrough criteria. Phosphorous breakthrough analysis calculations are mass based, therefore the limit will be a load based discharge limit.

Conducting a phosphorous breakthrough analysis of each drainfield is a less conservative means of calculating the effects of phosphorous to state waters. Due to the proximity and similar orientation of the drainfields the Department assumes both drainfields are one for the purpose of calculating phosphorous breakthrough. Using the distance to surface water (Spokane Creek) approximately 3,200 feet east and down gradient of the proposed drainfields the breakthrough time for phosphorus is 82.4 years. This breakthrough time is considered nonsignificant pursuant to Montana's Nondegradation criteria [ARM 17.30.715(1)(e)].

A phosphorous breakthrough would occur in 50 years (the level of significant degradation) at an effluent concentration of 10.13 mg/ L and load of 2.3 lbs/day or 834.9 lbs/year. Therefore the effluent limit for the Total Phosphorous load discharged to the drainfield shall not exceed 2.3 lbs/day or 834.9 lbs/year for Outfall 001a and 001b. The water quality based effluent limit for each outfall will therefore be set at 2.3 lb/day.

E. Escherichia Coli

A wastewater treatment system that is appropriately sited and operating properly should remove most if not all of the pathogenic bacterial indicators within 2 to 3 feet of the drainfields infiltrative surface (USEPA, 2002). An Escherichia Coli (E coli) limit has not been established in this permit due to the following site-specific criteria:

- The drainfield is pressured-dosed, which minimizes saturated conditions and therefore maximizes the die-off rate in natural sediments.
- The depth to groundwater based on onsite wells is approximately 50 feet
- The permittee is required to meet the E Coli ground water standard of less than 1 organisms/100 ml wastewater at the end of the mixing zone.

The systematic dosing of the drainfield and the soil matrix of the drainfield provide natural disinfection, which will enable the DEQ-7 human health standard of <1 organism/100 ml to be achieved in the groundwater. Pathogen transport research indicates a 3-log decrease in pathogens for every meter of horizontal movement through the vadose zone and a 6-log decrease

in pathogen transport for every 20 m in vertical transport through the saturated zone (Woessner, 1998). The proposed system discharges the effluent about 15 m above the ground water; additional treatment will occur prior to reaching the water table. A 3-log removal in the vadose zone indicates less than 1 colony per 100 ml within 3-feet of the discharge. A Mixing Zone will not be granted for pathogens.

The proposed water quality and nondegradation effluent limits for outfall 001a and 001b are presented in Table 3.

Table 3. Water-Quality Based Effluent and Nondegradation Limits Outfall 001a and 001b

Parameter	Concentration (mg/L) Daily Maximum (1)	90 Day Average Load (2) (lbs/ per day)
Total Nitrogen as N	40.2	9.1
Total Phosphorus as P	10.13	2.3

(1) See definitions, Part I.A of the permit

(2) load calculation: lb/d = (mg/L) x flow (gpd) x 8.34 x 10^{-6}

F. Mixing Zone

The permittee has proposed to discharge all wastewater from Outfalls 001a and 001b to ground water. Ground water in the immediate vicinity of the discharge is classified as class I water as defined by ARM 17.30.1006 (1) (a) and discussed in section IV, A of this document. The applicant requested a standard 500-foot ground water mixing zone. Due to the distance separating the two drainfields A ground water mixing zone will be granted for each drainfield, for the single parameter of nitrate.

V. Final Effluent Limits

The proposed final effluent limitations for Outfall 001a and 001b are summarized in Table 4 and are based on water quality, nondegradation significance water quality criteria and the water quality standards of DEQ-7 discussed in previous sections. Water quality standards for human health (DEQ-7, February 2006) apply to concentrations of substances in Class I ground waters. Pursuant to 75-5-402 (3), ARM 17.30.1031(2) and ARM 17.30.1006 (1)(a) the Department will implement limits such that the discharge from outfall 001 shall not cause increase of a parameter to a level that renders the water harmful, detrimental or injurious to the beneficial uses listed for class I water. Class I ground water is to be maintained for the following beneficial uses with little or no treatment: public and private water supplies, culinary and food processing purposes, irrigation, drinking water for livestock and wildlife and for industrial and commercial uses.

Permit application materials received by the Department in February 26, 2008 indicated that the applicant is requesting a mixing zone. As such the permittee will be required to meet the ground water quality standards at the down gradient edge of the 500 ft mixing zone. The permittee submitted technical information indicating a design capacity of 27,250 gpd. The design flow is the peak flow (daily or instantaneous) for sizing treatment facilities, such as pumps, piping, storage and adsorption systems and means the average daily flow for sizing the treatment system. Flows in exceedance of the design flow would not be expected to be treated adequately by the

system. The combined flow limit from outfalls 001a and 001b shall not exceed the design capacity of 27,250 gpd based on the daily average.

Table 4. Final Numeric Effluent Limits for Outfall 001a and 001b

Parameter	Concentration (mg/L) Daily Maximum [(1)]	90 Day Average Load[(2)] (lbs/ per day)
Total Nitrogen as N	26	5.9
Total Phosphorus as P	10.13	2.3

(1) See definitions, Part I.A of the permit
(2) 90 day average load calculation: lb/d = (mg/L) x flow (gpd) x 8.34 x 10^{-6}
NA = Not Applicable

VI. Monitoring Requirements

Effluent monitoring is essential to ensure the effective treatment and consistency of the wastewater discharged from the facility. Effluent limits are established to protect the ground water from a change in water quality that would cause degradation [ARM 17.30.715] or limit a beneficial use [ARM 17.30.1006(1)(a)]. Samples or measurements shall be representative of the volume and nature of the monitored discharge. Effluent quality monitoring shall occur from the 3,400 gallon dosing tanks immediately prior to discharge into the drainfields.

The permittee shall monitor the effluent for the constituents in Table 5 at the frequency and with the type of measurement indicated. If no discharge occurs during the entire monitoring period, it shall be stated in a Discharge Monitoring Report (DMR) that no discharge occurred.

The permittee shall continuously monitor the flow of the effluent and report the gallons per day discharged based on the daily maximum. The effluent flow measurement method shall be either by flow meter and recorder or a totalizing flow meter; dose counts or pump run-times will not be accepted. Flow measurement equipment must have the ability to report a daily maximum flow. To ensure that the Total phosphorous load is calculated correctly, an accurate maximum daily flow must be measured. Maximum daily flow shall be measured when required sampling is conducted (flow measurement must correspond to sample collection to calculate an accurate load). The effluent flow rate is to be a measured and reported as a maximum daily flow.

Table 5. Outfall 001a and 001b Parameters Monitored Prior to Discharge to the Drainfield

Parameter	Frequency	Sample Type[(1)]
Effluent Flow Rate, gpd[(2) (3)]	Daily[(1)]	Continuous[(1)]
Biological Oxygen Demand (BOD_5), mg/L	Quarterly	Composite
Total Kjeldahl Nitrogen (TKN), mg/L	Quarterly	Composite
Nitrate as N	Quarterly	Composite
NO_3+NO_2 as N, mg/L	Quarterly	Composite
Ammonia, as N, mg/L	Quarterly	Composite
Total Phosphorus (as P), mg/L	Quarterly	Composite
Total Suspended Solids (TSS) mg/L	Quarterly	Composite

Total Nitrogen (as N), mg/L	Quarterly	Calculated
Total Nitrogen (as N), lb/d	Quarterly	Calculated
Total Phosphorus (as P), lb/d	Quarterly	Calculated
Chloride, mg/L	Quarterly	Composite

(1) See definitions, Part I.A of the permit
(2) If no discharge occurs during the reporting period, "no discharge" shall be recorded on the DMR report form
(3) Permittee is to report the daily maximum and 90 day average

A. Ground Water Monitoring

Ground water monitoring will be required in this permit due to the following site-specific criteria:

- The presence of a high quality receiving water and the need to protect existing and future beneficial uses.
- The need to distinguish the effects to ground water of the discharging wastewater treatment system.
- The shallow aquifer is a coarse grained alluvial aquifer with a relatively high hydraulic conductivity.
- This area is experiencing rapid growth and development.

The permittee will be required to monitor the ground water quality on the hydraulically down gradient edge of both mixing zones. Therefore two monitoring wells shall be installed in the centerline of the terminus of each 500 foot mixing zone for outfalls 001a and 001b. These wells shall serve as a monitoring point for determination of exceedances of the ground water quality standards. This shall be screened from the top of the high water table to 15 feet below the low water table. The permittee will conduct groundwater quality monitoring from both wells on a quarterly basis for the parameters listed in Table 6.

Table 6. Monitoring Parameters for Monitoring Wells:

Parameter	Frequency	Sample Type (1)
Static Water Level (SWL) (feet below the casing top)	Quarterly	Instantaneous
Specific Conductance, µmhos/cm	Quarterly	Grab
Chloride, mg/L	Quarterly	Grab
Escherichia Coli (Organisms/100 m*l*)	Quarterly	Grab
Total Ammonia, as N, mg/L	Quarterly	Grab
Nitrate as N	Quarterly	Grab
NO_3+NO_2 as N, mg/L	Quarterly	Grab
Total Phosphorous	Quarterly	Grab

(1) See definitions, Part I.A of this permit

VII. Significance Determination

The Department has determined that the discharge constitutes a new or increased source and is subject to Montana Nondegradation Policy (75-5-303, MCA; ARM 17.30.702(16)). The Department has determined this discharge to be nonsignificant with respect to nitrogen concentrations discharged to state waters. Nitrogen concentrations are predicted to be less than 7.5 mg/L (DEQ nitrate sensitivity analysis 2008). Phosphorus load limits are based on nondegradation significance criteria for 50-year break-through to surface water in accordance with ARM 17.30.715(1)(e) (DEQ phosphorous break through analysis 2008). Therefore, discharge in compliance with the limitations of this permit constitutes nonsignificant degradation.

VIII. Special Conditions/Compliance Schedules

a) Effluent Flow Measurement

The permittee will be required to monitor effluent flow [75-5-602(3)]. To ensure that the total phosphorous load is calculated correctly, an accurate maximum daily flow must be measured. The Department requires that samples or measurements be representative of the volume and nature of the monitored discharge. Effluent flow shall be monitored following treatment in the RTF's at the last point of control prior to discharge into the drainfield. The measurement method shall be either by recorder or a totalizing flow meter dose counts or pump run-times will not be accepted. The permittee shall monitor the flow of the effluent continuously. The permittee shall install the above mentioned flow monitoring equipment prior to discharge of wastewater to state waters.

b) Monitoring Well Installation

Within 90 days of the effective date of the permit the permittee shall submit to the Department for approval a plan for ground water monitoring well installation as well as a brief summary of a monitoring, sampling and analysis plan for monitoring wells installed onsite. The plan shall include the location, conceptual design and construction methods of the planned ground water monitoring wells, and the monitoring, sampling and analysis methods that will be used to meet the monitoring required in the Permit. The well shall be located in the centerline of the terminus of each 500 foot mixing zone.

Prior to discharge the permittee shall submit to the Department a brief report or letter documenting the results of the monitoring well installation including the final location of the installed monitoring wells, construction details for the well and a report on ground water quality in the from the well. Ground water quality analysis shall include those parameters listed in Table 6. Ground water quality monitoring shall begin upon installation of the well and continue though the duration of the permit.

IX. Information Source

In the development of the effluent limitations, monitoring requirements and special conditions for the draft permit, the following information sources were used to establish the basis of the draft permit and are hereby referenced:

ARM Title 17, Chapter 30, Sub-chapter 7 - Nondegradation of Water Quality, March 2000.

ARM Title 17, Chapter 30, Sub-chapter 10 - Montana Ground Water Pollution Control System (MGWPCS), March 2002

Environmental Protection Agency, U.S. EPA NPDES Permit Writers Manual, December 1996

Environmental Protection Agency, Design Manual: Onsite Wastewater Treatment System Manual. EPA 625/R-00/008, 2002.

Fetter, C.W., Applied Hydrogeology., 1988

Gateway Engineering and Surveying Inc, Montana Ground Water Pollution Control System Permit Application., 2007 and supplemental application materials submitted 2008

NSF International, Environmental Protection Agency, Environmental Technology Verification Report., EPA/600/R-06/130. 2006.

Regensburger, E. Nutrient-Reducing Wastewater Treatment System Designation Form. Montana Department of Environmental Quality. 2004

Woessner, W., Thomas, Troy., Ball, Pat and DeBorde, Dan C., (April 1998), Virus Transport in the Capture Zone of a Well Penetrating a High Hydraulic Conductivity Aquifer Containing a Preferential Flow Zone: Challenges to Natural Disinfection. , University of Montana., Missoula, Montana.

United States Department of Agriculture, Natural Resource Conversation Service, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx .

Prepared By: Louis Volpe July 11, 2008